

# PATENT ABSTRACTS OF JAPAN

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(21)Application number : 2002-162673 (71)Applicant : MATSUSHITA ELECTRIC IND  
CO LTD

(22)Date of filing : 04.06.2002 (72)Inventor : OTSUKA TAKASHI  
MORITA KIYOYUKI

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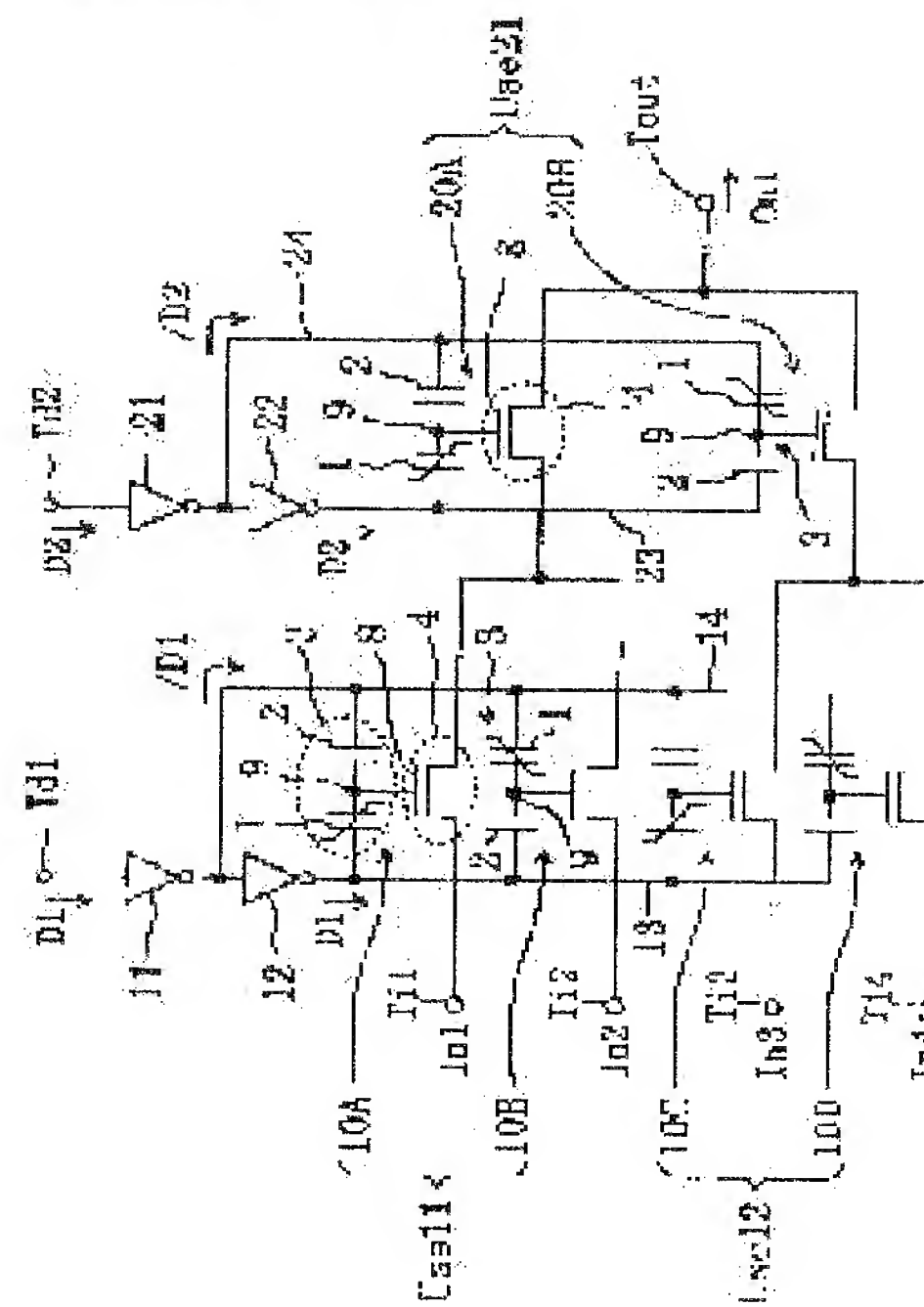
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## (54) NONVOLATILE SELECTOR, AND INTEGRATED CIRCUIT DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a selector which has a nonvolatile storage function and a semiconductor integrated circuit device where it is arranged.

SOLUTION: For a multiplexer, the preceding gate is equipped with the first to fourth switches 10A-10D, and each switch 10 is composed of a series capacitor 3 and an FET 4. The series capacitor 3 has a ferroelectric capacitor 1 and a paraelectric capacitor 2, and its center electrode is connected to the gate electrode 8 of an FET 4. In a unit selector U<sub>sel</sub> consisting of the switches 10A and 10B, the voltage of the center node 9 is distributed according to the capacity difference between two capacitors, so that each FET 4 of the switches 10A and 10B may be switched ON and OFF alternately, according to the logical values 1 and 0 of a selection signal D1, and its operation state is stored without volatility in the ferroelectric capacitor 1.



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CLAIMS

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[Claim(s)]

[Claim 1]A selector which is provided with at least one unit selector, intercepts passage of at least one input signal in two or more input signals according to a selection signal and a reversal selection signal, and passes other input signals, comprising:

At least one in-series capacitor which the above-mentioned unit selector is mutually connected in series on both sides of an intermediate node, and at least one side has the 1st capacitor and the 2nd capacitor which are ferroelectric capacitors, and receives the above-mentioned selection signal and a reversal selection signal in both ends.

A gate electrode connected to an intermediate node of the above-mentioned in-series capacitor.

The 1st FET that has the 1st and 2nd impurity diffused layer that functions as the above-mentioned input part and an outputting part.

A gate electrode connected to an intermediate node of the above-mentioned in-series capacitor, and the 1st and 2nd impurity diffused layer that functions as the above-mentioned input part and an outputting part.

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## CLAIMS

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[Claim(s)]

[Claim 1] A selector which is provided with at least one unit selector, intercepts passage of at least one input signal in two or more input signals according to a selection signal and a reversal selection signal, and passes other input signals, comprising:

At least one in-series capacitor which the above-mentioned unit selector is mutually connected in series on both sides of an intermediate node, and at least one side has the 1st capacitor and the 2nd capacitor which are ferroelectric capacitors, and receives the above-mentioned selection signal and a reversal selection signal in both ends.

A gate electrode connected to an intermediate node of the above-mentioned in-series capacitor.

The 1st FET that has the 1st and 2nd impurity diffused layer that functions as the above-mentioned input part and an outputting part.

A gate electrode connected to an intermediate node of the above-mentioned in-series capacitor, and the 1st and 2nd impurity diffused layer that functions as the above-mentioned input part and an outputting part.

[Claim 2] In the nonvolatile selector according to claim 1 -- the above -- one in-series capacitor, even if small, An intermediate node of the above-mentioned 1st serial capacitor is connected to a gate electrode of the 1st FET of the above including the 1st and 2nd in-series capacitor, Mutually, an intermediate node of the above-mentioned 2nd serial capacitor is connected to a gate electrode of the 2nd FET of the above, and a conductivity type of the 1st and 2nd FET of the above is equal, and The 1st capacitor of the above-mentioned 1st serial capacitor, With the 2nd capacitor of the above-mentioned 2nd serial capacitor. It is connected by the 1st common wiring and the 2nd capacitor of the above-mentioned 1st serial capacitor, and the 1st capacitor of the above-mentioned 2nd serial capacitor, A nonvolatile selector, wherein it is connected by the 2nd common wiring, the above-mentioned inversion signal or a reversal selection signal is supplied from the 1st wiring of the above and the above-mentioned reversal inversion signal or an inversion



signal is supplied from the 2nd wiring of the above.

[Claim 3] In the nonvolatile selector according to claim 2, each 1st capacitor and each 2nd capacitor in the above-mentioned 1st and 2nd serial capacitor, A nonvolatile selector being one pair each of ferroelectric capacitors which have a ferroelectrics film in which the hysteresis characteristics of polarization over impressed electromotive force differ mutually, respectively.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the integrated circuit device provided with the selector and this which are used for various logic circuits, and relates to what has a nonvolatile memory storage function especially.

[0002]

[Description of the Prior Art]One of the basic logic circuits of MISFET used widely in recent years has a multiplexer demultiplexer. It is a circuit which a multiplexer is also called selection circuitry, a demultiplexer is also called distribution circuit, and both embrace a selection signal, and chooses or distributes input data.

[0003]Drawing 14 (a) and (b) is a figure showing the input/output relation according to the conventional electric diagram and selection signal of the multiplexer of four inputs in a table. As shown in drawing 14 (a), the conventional multiplexer, The four preceding paragraph side NMISFET 1001-1004 which receive four input signal In1, In2, In3, and In4, respectively. Latter-part side NMISFET1005 which undergoes the output of preceding paragraph side [ two ] NMISFET1001-1002, Latter-part side NMISFET1006 which undergoes the output of preceding paragraph side [ two ] NMISFET1003-1004, The output terminal 1007 which undergoes the output of latter-part side [ two ] NMISFET1005-1006, Preceding paragraph side SRAM1011 which supplies the selection signal D1 to preceding paragraph side [ two ] NMISFET1001-1003, and supplies a reversal selection signal / D1 to preceding paragraph side [ two ] NMISFET1002-1004, respectively, It has SRAM1012 which supplies the selection signal D2 to latter-part side NMISFET1005, and supplies a reversal selection signal / D2 to latter-part side NMISFET1006, respectively.

[0004]As shown in drawing 14 (b), according to the selection signal D1 and four kinds of combination of each logical value of D2, the output signal Out becomes settled uniquely in either of the input signals In1-In4. That is, corresponding to 1 to 1, the output signal Out is changed to the selection signal D1 and the combination of D2.

[0005]On the other hand, a demultiplexer considers operation with opposite input/output

relation as a multiplexer.

Supposing the input signals In1-In4 are inputted from the output terminal 1007, according to the selection signal D1 and four kinds of data of D2, either of the input signals In1-In4 will be uniquely outputted from the input terminal corresponding to the input signals In1-In4 shown in drawing 14 (a).

[0006]

[Problem(s) to be Solved by the Invention]As mentioned above, the control data is saved beforehand at SRAM (FF), and the contents are made to perform multiplexer operation in the conventional multiplexer. Therefore, when the data of SRAM is held, in the state where the power supply of the circuit is on, operation of a multiplexer follows the memory content of SRAM, but. After a power supply is disconnected, in order to operate a multiplexer, a means to make data hold is needed for SRAM.

[0007]Although the data stored in this SRAM is stored in nonvolatile memory, such as a flash memory, and downloading the data of nonvolatile memory to SRAM of a multiplexer is also considered at the time of operation, Nonvolatile memory and operation called download will be needed separately.

[0008]In the portable device used mostly in recent years, the function for it to be nonvolatile and to memorize operation from a viewpoint of current supply, such as a cell, or power consumption is demanded, and when there is no function memorized only for volatility, there is a problem that re-download of the data of a power up will be needed.

[0009]Also when applying circuits, such as a multiplexer, to an operation and a neuro-device which performs study using the last processed data, that a memory content is volatility poses a problem.

[0010]Then, this invention persons tried to constitute circuits, such as a multiplexer, using the device which has a nonvolatile memory storage function.

[0011]As a typical thing of a device which has a nonvolatile memory storage function, the flash memory and the ferroelectric memory (FRAM (registered trademark)) have already appeared in a commercial scene. Especially, The gate dielectric film of MISFET (Metal Insulator Semiconductor Field Effect Transistor) with a ferroelectrics film. Constituted MFSFET (Metal Ferroelectrics Semiconductor FET), MFMSFET (Metal Ferroelectrics Metal Semiconductor FET), MFMISFET (Metal Ferroelectrics MetalInsulator Semiconductor FET) (these are hereafter named MFS type FET generically) is proposed. Functioning as nonvolatile memory small [ this MFS type FET ] and high-speed is expected.

[0012]MFS type FET uses that a remanence arises for a ferroelectrics film, even after polarization of a ferroelectrics film will change and impression of voltage will stop, if the voltage more than the coercive electric field of a ferroelectric is impressed between a semiconductor substrate and a gate electrode. That is, since MFS type FET serves as no MARION or no MARIOFU according to direction of a remanence, one of this FET or a difference of OFF is memorized as information.



[0013]However, in order to carry out polarization inversion of a ferroelectrics film. When the logical values L (0V) and H (power supply voltage VDD) of the binary which needs to impress voltage between gate semiconductor substrates and is used by the usual logic element are used, In order to reverse the remanence of a ferroelectrics film, it is necessary to apply field reversing between substrate-gate electrodes, and there is a problem that element structure becomes complicated.

[0014]The purpose of this invention is to provide the integrated circuit device using the nonvolatile selector and this which perform nonvolatile signal selection operation using FET of a different simple structure from conventional MFS type FET, having a ferroelectrics film.

[0015]

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TECHNICAL FIELD

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[Field of the Invention]This invention relates to the integrated circuit device provided with the selector and this which are used for various logic circuits, and relates to what has a nonvolatile memory storage function especially.

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[Translation done.]



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PRIOR ART

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[Description of the Prior Art]One of the basic logic circuits of MISFET used widely in recent years has a multiplexer demultiplexer. It is a circuit which a multiplexer is also called selection circuitry, a demultiplexer is also called distribution circuit, and both embrace a selection signal, and chooses or distributes input data.

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EFFECT OF THE INVENTION

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[Effect of the Invention]According to this invention, offer of the selector which can memorize an unvolatilized back operating state, and the integrated circuit which has arranged the selector can be aimed at.

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TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention]As mentioned above, the control data is saved beforehand at SRAM (FF), and the contents are made to perform multiplexer operation in the conventional multiplexer. Therefore, when the data of SRAM is held, in the state where the power supply of the circuit is on, operation of a multiplexer follows the memory content of SRAM, but. After a power supply is disconnected, in order to operate a multiplexer, a means to make data hold is needed for SRAM.



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## MEANS

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[Means for Solving the Problem]A nonvolatile selector of this invention is provided with at least one unit selector, According to a selection signal and a reversal selection signal, are a selector which intercepts passage of at least one input signal in two or more input signals, and passes other input signals, and the above-mentioned unit selector, At least one in-series capacitor which it is mutually connected in series on both sides of an intermediate node, and at least one side has the 1st capacitor and the 2nd capacitor which are ferroelectric capacitors, and receives the above-mentioned \*\*\*\*\* and a reversal selection signal in both ends, The 1st FET that has a gate electrode connected to an intermediate node of the above-mentioned in-series capacitor, and the 1st and 2nd impurity diffused layer that functions as the above-mentioned input part and an outputting part, It has the 2nd FET that has a gate electrode connected to an intermediate node of the above-mentioned in-series capacitor, and the 1st and 2nd impurity diffused layer that functions as the above-mentioned input part and an outputting part, When a selection signal and a reversal selection signal are received in both sides of the above-mentioned in-series capacitor, in potential of the above-mentioned intermediate node, according to a logical value of the above-mentioned inversion signal, one side switches to ON in [ another side / OFF ] shift among the 1st and 2nd FET of the above.

[0016]When a logical value of a selection signal is 1 by this, supposing the 1st FET is set to ON and the 2nd FET is come by off in a unit selector according to potential of an intermediate node, Since the 1st FET is come by off and the 2nd FET is set to ON according to potential of an intermediate node when a logical value of a selection signal is 0, a selector function is secured. And a simple selector of element structure is realized, having a nonvolatile memory storage function by a remanence of a ferroelectric capacitor, since potential of the intermediate node is held.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1]It is a circuit diagram of the nonvolatile multiplexer which is a nonvolatile selector in a 1st embodiment.

[Drawing 2]It is a characteristic figure showing change of polarization of the ferroelectrics film to the voltage impressed to the both ends of a ferroelectric capacitor.

[Drawing 3]It is a characteristic figure showing change of polarization of the paraelectrics film to the voltage impressed to the both ends of a paraelectrics capacitor.

[Drawing 4]It is a figure making a table input/output relation over the combination of the selection signal D1 and the \*\*\*\* value of D2 and in which showing it.

[Drawing 5](a) and (b) are a top view showing the constructional example of the unit selector of a 1st embodiment, and a sectional view in a Va-Va line.

[Drawing 6]It is a circuit diagram of the multiplexer concerning a 2nd embodiment.

[Drawing 7]It is a circuit diagram of the nonvolatile multiplexer which is a nonvolatile selector in a 3rd embodiment.

[Drawing 8]It is a top view showing the constructional example of the preceding paragraph gate of a 3rd embodiment.

[Drawing 9]It is a circuit diagram of the multiplexer concerning a 4th embodiment.

[Drawing 10]It is a circuit diagram of the nonvolatile multiplexer which is a nonvolatile selector in a 5th embodiment.

[Drawing 11]It is a circuit diagram of FPGA concerning a 6th embodiment.

[Drawing 12]It is a circuit diagram showing the composition of some recognition systems concerning a 7th embodiment.

[Drawing 13]It is a block circuit diagram showing roughly the composition of the code chip circuit concerning an 8th embodiment.

[Drawing 14](a) and (b) are the figures showing the input/output relation according to the conventional electric diagram and selection signal of the multiplexer of four inputs in a table.

[Description of Notations]

1 Ferroelectric capacitor  
2 Paraelectrics capacitor  
3 In-series capacitor  
4 FET  
8 Gate electrode  
9 Intermediate node  
10 Switch portion  
11 Inverter  
12 Inverter  
13 Signal wire  
14 Signal wire  
21 Inverter  
22 InAB  
23 Signal wire  
24 Signal wire  
Ti input terminal  
Tout output terminal  
Td control terminal  
Use unit selector

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[Translation done.]



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CORRECTION OR AMENDMENT

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[Kind of official gazette] Printing of amendment by the regulation of 2 of Article 17 of Patent Law

[Section classification] The 3rd classification of the part VII gate

[Publication date] July 18 (2003.7.18), Heisei 15

[Publication No.] JP,2003-115754,A (P2003-115754A)

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[Application number] Application for patent 2002-162673 (P2002-162673)

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H01L 27/10 444 Z

27/06 102 A

[Written amendment]

[Filing date]April 7, Heisei 15 (2003.4.7)

[Amendment 1]

[Document to be Amended]Specification

[Item(s) to be Amended]The name of an invention

[Method of Amendment]Change

[Proposed Amendment]

[Title of the Invention]Nonvolatile selector

[Amendment 2]

[Document to be Amended]Specification

[Item(s) to be Amended]Claim

[Method of Amendment]Change

[Proposed Amendment]

[Claim(s)]

[Claim 1]It is the nonvolatile selector provided with at least one unit selector,

The above-mentioned unit selector has two or more switch parts,

Each above-mentioned switch part,

An in-series capacitor sequence which consists of the 1st capacitor and the 2nd capacitor which were connected in series,

A transistor switched with potential which is connected to an intermediate node inserted between the 1st capacitor of the above, and the 2nd capacitor, and appears in the above-mentioned intermediate node,

The owner is each carried out,

Each transistor of two or more above-mentioned switch parts is connected to a common output terminal,

Each transistor of two or more above-mentioned switch parts is connected to two or more input terminals which became independent, respectively,

The 1st capacitor of switch part A consists of ferroelectric capacitors,

The 2nd capacitor of switch part A consists of a paraelectrics capacitor or a low capacity object capacitor,

The 1st capacitor of switch part B consists of a paraelectrics capacitor or a low capacity object capacitor,

The 2nd capacitor of switch part B consists of ferroelectric capacitors,

Inside of potential which appears in potential and the above-mentioned intermediate node of switch part B which appear in the above-mentioned intermediate node of switch part A, A nonvolatile selector to which an input terminal connected to a transistor which became the potential to which one side turns OFF a transistor, became the potential to which another side makes a transistor one, and was turned on among two or more input terminals, and the above-mentioned output terminal are electrically connected.

[Claim 2]It is the nonvolatile selector according to claim 1,  
 The 2nd capacitor of switch part A consists of a paraelectrics capacitor,  
 A nonvolatile selector which the 1st capacitor of switch part B becomes from a paraelectrics capacitor.

[Claim 3]It is the nonvolatile selector according to claim 1,  
 The 2nd capacitor of switch part A consists of a low capacity object capacitor,  
 A nonvolatile selector which the 1st capacitor of switch part B becomes from a low capacity object capacitor.

[Claim 4]It is the nonvolatile selector according to claim 1,  
 It has at least two unit selectors,  
 The 1st unit selector has two or more above-mentioned switch parts,  
 The 2nd unit selector is provided with a transistor connected to an intermediate node which the above-mentioned switch part A has, and a transistor connected to an intermediate node which the above-mentioned switch part B has,  
 A transistor connected to an intermediate node which the above-mentioned switch part A has, and a transistor connected to an intermediate node which the above-mentioned switch part B has are connected to a common output terminal,  
 A nonvolatile selector connected to two or more input terminals in which a transistor connected to an intermediate node which the above-mentioned switch part A has, and a transistor connected to an intermediate node which the above-mentioned switch part B has become independent, respectively.

[Claim 5]It is the nonvolatile selector according to claim 1,  
 A nonvolatile selector provided with an output signal attaching part which memorizes an output state of an output terminal by un-volatilizing.

[Claim 6]It is the nonvolatile selector according to claim 5,  
 The above-mentioned output signal attaching part is provided with an in-series capacitor which connects a ferroelectric capacitor and a paraelectrics capacitor by an intermediate node,

A nonvolatile selector comprising:  
 An inverter which reverses a signal outputted from the above-mentioned unit selector, and is sent to the above-mentioned ferroelectric.  
 An inverter formed between the above-mentioned intermediate node and the above-mentioned output terminal.

[Claim 7]It is the nonvolatile selector according to claim 1,  
 A nonvolatile selector comprising:  
 The 1st capacitor of the above of switch part A which consists of the above-mentioned ferroelectric capacitor.  
 A ferroelectrics film in which the hysteresis characteristic of polarization over impressed electromotive force differs from the 2nd capacitor of switch part B which consists of the



above-mentioned ferroelectric capacitor mutually.

[Claim 8]It is the nonvolatile selector according to claim 1,

A nonvolatile selector comprising:

The 1st capacitor of the above of switch part A which consists of the above-mentioned ferroelectric capacitor.

A ferroelectrics film in which material is the same as the 2nd capacitor of switch part B which consists of the above-mentioned ferroelectric capacitor, and thickness differs.

[Claim 9]It is the nonvolatile selector according to claim 1,

A nonvolatile selector comprising:

The 1st capacitor of the above of switch part A which consists of the above-mentioned ferroelectric capacitor.

A ferroelectrics film in which material is the same as the 2nd capacitor of switch part B which consists of the above-mentioned ferroelectric capacitor, and area differs.

[Claim 10]It is the selector provided with at least one unit selector,

The above-mentioned unit selector,

An in-series capacitor sequence which consists of the 1st capacitor and the 2nd capacitor which were connected in series,

It is connected to an intermediate node inserted between the 1st capacitor of the above, and the 2nd capacitor, is connected to the 1st transistor and the above-mentioned intermediate node which are switched with potential which appears in the above-mentioned intermediate node, and has the 2nd transistor switched with potential which appears in the above-mentioned intermediate node,